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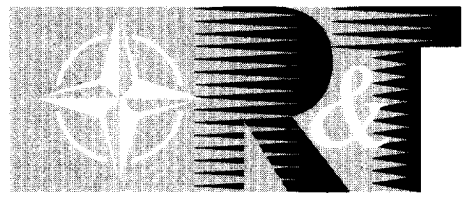

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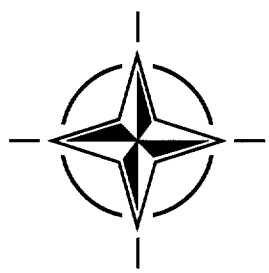
RTO TECHNICAL REPORT 8

Land Operations in the Year 2020 (LO2020)

(Opérations terrestres à l'horizon 2020 (LO2020))

This study was carried out at the request of SHAPE (Supreme Headquarters Allied Powers Europe), and was managed by the Studies, Analysis and Simulation Panel (SAS).



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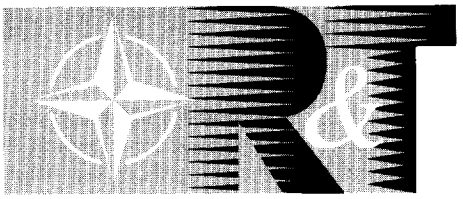

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- SCI Systems Concepts and Integration
- SET Sensors and Electronics Technology
- IST Information Systems Technology
- AVT Applied Vehicle Technology
- HFM Human Factors and Medicine

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Land Operations in the Year 2020 (LO2020)

(RTO TR-8)

Executive Summary

This study, which was requested by SHAPE, identifies the most critical key and emerging technologies and the impact they will have on military land forces in the year 2020. It also addresses the likely nature of the battlefield, the types of land forces, and their characteristics and capabilities. This will help NATO plan its research and development, and SHAPE will use it as input to the NATO Defence Planning Process.

Main Conclusions

Although there will be a wide range of demands on NATO forces in 2020, the highest priority is the ability to fight a full-scale conflict. War-fighting must remain the basic ethos, but with the ability to adapt to other types of operation. Enhanced protection against the full spectrum of attacks must be incorporated into NATO doctrine and force structure.

The battle space in 2020 will be variable in density, non-linear, and more dispersed. It will be cellular in nature, multi-directional and increasingly determined by what is above the battlefield in air and space. The most demanding, yet probable, environment for conflict is likely to be urban.

Interoperability will continue to pose a challenge as NATO incorporates new members. Harmonisation of doctrine, information systems, and communications is essential.

Information dominance and superiority will remain a key military objective.

Reduction in logistic drag will be essential for effective military operations in 2020.

Impact of Technology

Force structures will need to change in order to exploit technology to the fullest.

The following broad technology areas are deemed to be of special importance:

> High Power Electrical Technologies, Directed Energy Weapons, Computing Technologies, Communication Technologies, Electronic/Information Warfare Technologies, Electronic Devices, Biotechnology, Structural Materials Technologies, Human Factors and Man-Machine Interfaces, Precision Attack Technologies, and Automation and Robotics.

Each of these areas is underpinned by a large number of basic technologies. Four key emerging technology areas were identified for further research projects:

> High Power Battlefield Electrical Systems, Biotechnology, Micro Electrical-Mechanical Systems (MEMS), and Novel Energetic Materials.

Several emerging technology applications were also identified:

> Precision Attack, Sensing, Information Fusion, Digitisation, Non-Lethal Weapons and Barriers, Robotics, Simulation and Synthetic Environments, and Modular Systems.

Advances in these areas will contribute to tempo, sustainability, manoeuvre, protection, interoperability, acquisition, force structure, and soldier systems – all the major military requirement areas identified in the study.

Major Recommendations

- NATO should provide the focus for the development of key technologies with special emphasis on standardisation and interoperability between member nations.
- The NATO Research and Technology Organisation should initiate studies or collaborative research programmes on the most promising emerging technologies.
- SHAPE should consider the conclusions and recommendations of this study for inclusion in the 2000 Defence Planning Cycle.
- SHAPE should establish a NATO military working group to study joint and combined concepts and doctrine.

A fuller overview follows the contents list.

Opérations terrestres à l'horizon 2020 (LO2020)

(RTO TR-8)

Synthèse

Cette étude, qui a été réalisée à la demande du SHAPE, identifie les technologies clés et naissantes les plus importantes et leur impact sur les forces militaires terrestres à l'horizon 2020. Elle examine également la nature probable du champ de bataille, les types de forces terrestres, leurs caractéristiques et capacités. Elle sera d'une grande utilité pour la planification des activités de recherche et développement de l'OTAN et servira au SHAPE dans le cadre de sa contribution aux Procédures de planification de la défense de l'OTAN.

Conclusions principales

Vraisemblablement, les forces de l'OTAN seront appelées à réaliser des interventions très diverses d'ici l'an 2020, mais la priorité numéro un demeurera la capacité de livrer une bataille de grande envergure. La conduite de la guerre doit subsister en tant que ligne directrice, mais avec la possibilité d'adaptation à d'autres types d'opérations. La protection renforcée contre l'éventail complet d'attaques possibles doit être incorporée dans la structure des forces de l'OTAN, ainsi que dans sa doctrine.

L'espace de bataille de l'an 2020 sera variable en densité, non-linéaire et plus dispersé. Il sera de nature cellulaire, multidirectionnelle, et de plus en plus déterminé par les éléments aériens et spatiaux se trouvant au-dessus du champ de bataille. L'environnement urbain sera l'environnement de conflit le plus difficile, mais en même temps le plus probable.

L'interopérabilité continuera de poser des problèmes avec l'élargissement de l'OTAN. L'harmonisation des doctrines, et des systèmes d'information et communications est essentielle.

La domination de l'information et la supériorité demeureront un objectif militaire clé.

La diminution des délais d'acheminement de la logistique sera indispensable à la réussite des opérations militaires en l'an 2020.

L'impact des technologies

Il faudra procéder à des changements au niveau des structures des forces afin de profiter au maximum des nouvelles technologies.

Les grands domaines technologiques suivants sont jugés d'une importance particulière :

Les technologies électriques à grande puissance, les armes à énergie dirigée, les technologies de l'informatique, les technologies des télécommunications, les technologies électronique/de la guerre de l'information, les dispositifs électroniques, la biotechnologie, les technologies des structures et matériaux, les facteurs humains et les interfaces homme-machine, les technologies d'attaque de précision, l'automatisation et la robotique.

Chacun de ces domaines est soutenu par un grand nombre de technologies de base. Quatre nouveaux domaines technologiques clés ont été désignés pour de futurs projets de recherche :

Les systèmes électriques militaires de grande puissance, la biotechnologie, les systèmes microélectriques-mécaniques (MEMS) et les matériaux énergétiques novateurs.

Un certain nombre de nouvelles applications technologiques ont également été identifiées :

attaque de précision, télédétection, fusion des données, numérisation, armes non-létales et barrières, robotique, simulation et environnements synthétiques et systèmes modulaires.

Les progrès réalisés dans ces domaines apporteront leur contribution au rythme des opérations, au soutien des forces, à la manoeuvre, à la protection, à l'interopérabilité, aux approvisionnements, à la structure des forces et aux systèmes d'infanterie – en somme, à l'ensemble des grands domaines militaires identifiés par cette étude.

Recommandations principales

- L'OTAN doit être le point de convergence pour le développement des technologies clés en privilégiant la standardisation et l'interopérabilité entre pays membres.
- L'Organisation pour la recherche et la technologie de l'OTAN doit lancer des études et des projets de recherche en coopération sur les technologies naissantes les plus prometteuses.
- Le SHAPE doit réfléchir à la possibilité d'inclure les conclusions et les recommandations de cette étude dans le cycle de planification de la défense à l'horizon 2000.
- Le SHAPE doit établir un groupe de travail militaire OTAN pour étudier des concepts et des doctrines interarmées multinationaux.

La table des matières est suivie d'une synthèse plus complète.

Contents

List of Tables and Figures

Glossary of Acronyms and Terms

AAN	Army After Next
AD	Air Defence
ADC	Analog to Digital Converter
AFV	Armoured Fighting Vehicle
AH	Attack Helicopter
AHP	Analytical Hierarchy Process
AI	Artificial Intelligence
AIGaAs	Aluminium Gallium Arsenide
ANOVA	Analysis of Variance
AO	Adaptive Optics
APOD	Air Port of Disembarkation
APS	Active Protection System
AS90	155mm Artillery System
ASIC	Application Specific Integrated Circuits
ASTOR	Airborne Stand-Off Radar
ATGW	Anti-Tank Guided Weapons
ATM	Asynchronous Transfer Mode
BDA	Battle Damage Assessment
BDR	Battle Damage Repair
BLING	Bladed Ring
BLOS	Beyond-line of sight
C2I	Command, Control and Intelligence
C2W	Command and Control Warfare
C3	Command, Control and Communications
C3I	Command, Control, Communications and Intelligence
C4I	Command, Control, Communications, Computers, and Intelligence
CARM	Cyclotron Autoresonant Maser
CB	Chemical and Biological
CCD	Charge Coupled Device
CDA	Centre for Defence Analysis
CDAS	Counter Defensive Aid Suit
CDMA	Code Division Multiple Access
CIFF	Combat Identification Friend or Foe
CIS	Combat Information System
CIS	Command and Information System
CLOS	Command to Line of Sight
CMC	Ceramic Metal Composite
COLPRO	Collective Protection
COTS	Commercial off the Shelf
CRITECH	Critical Technology (exercise)
CTBW	Chemical, Toxin, and Biological Warfare
CW	Continuous-wave
DAC	Digital to Analog converter
DARPA	Defence Advanced Research Projects Agency
DAS	Defensive Aids Suit
DBMS	Database Management Systems
DERA	Defence Evaluation and Research Agency
DEW	Directed Energy Weapon
DF	Deuterium Fluoride
DLW	Directorate of Land Warfare
DMP	Defence Materiel Procurement
DNA	DeoxyriboNucleic Acid
DRG	Defence Research Group

DRR 99	Defence Requirements Review 1999
DRR	Defence Requirements Review
DSP	Digital Signal Processing
DU	Depleted Uranium
ECCM	Electro Counter-Counter-Measures
ECM	Electro Counter-Measures
EHF	Extremely High Frequency
EM	Electro Magnetic
EMC	Electro Magnetic Compatibility
EMI	Electromagnetic Interference
EMP	Electro Magnetic Pulse
EMS	Electro Magnetic Spectrum
EO	Electro Optic
EOD	Explosive Ordnance Disposal
ERA	Explosive Reactive Armour
ESD	Electrostatic Damage
ETC	Electro Thermal Chemical
EW	Electronic Warfare
Fe:InP	Iron: Indium Phosphide
FEL	Free Electron Lasers
FET	Field Effect Transistors
FIST	Future Infantry Soldier Technologies
FLIR	Forward Looking Infrared
FOG(M)	Fibre Optic Guided Munitions
FSED	Full Scale Engineering Development
FSS	Frequency Selecting Surfaces
FWM	Four-wave Mixing
GaAIAs	Gallium Aluminium Arsenide
GaAs	Gallium Arsenide
GaN	Gallium Nitride
GaP	Gallium Phosphide
GPS	Global Positioning System
GW	Giga-watt
HF	Hydrogen Fluoride
HPM	High-power Microwave
HTS	High Temperature Superconductors
HTSc	High Temperature Superconductivity
HUMINT	Human Intelligence
HUMS	Health and Usage Monitoring System
IEW	Information Electronic Warfare
IFF	Identification Friend or Foe
IHPTET	Integrated High Performance Turbine Engine Technology
InGaAsP	Indium Gallium Arsenide Phosphide
InGaN	Indium Gallium Nitride
InP	Indium Phosphide
InSb	Indium Antimonide
IPE	Individual Protection Equipment
IR	Infrared
IREB	Intense Relativistic Electron Beam
ISDN	Integrated Services Digital Network
ISO	International Standards Organisation
ISTAR	Intelligence, Surveillance, Target Acquisition and Reconnaissance
IT	Information Technology
KBS	Knowledge Based System
KE	Kinetic Energy
LADAR	Laser Radar
LAN	Local Area Network
LAW	Light Anti-Armour Weapon

LCD	Liquid Crystal Displays
LED	Light Emitting Diodes
LIDAR	Light Intensified Radar
LO	Land Operations
LO2020	Land Operations in the year 2020
LS	Land Systems
LTSS	Long Term Scientific Study
MBT	Main Battle Task
MDSS	Multi-Domain Smart Sensor
MEMS	Micro Electro Mechanical System
MILO	Magnetically Insulated Line Oscillator
MIPS	Million instructions per second
MLRS	Multiple Launch Rocket System
MLS	Multi Level Security
Mm/IR	Millimetre wave/Infrared
MMC	Metal Matric Composite
MMI	Man Machine Interface
MMIC	Monolithic Microwave Integrated Circuits
MMW	Millimetre wave
MNE	Multi-National Exercise
MO2015	Maritime Operations 2015
MOD	Ministry of Defence
MPM	Medium Power Microwave
MSG	Military Steering Group
MTI	Moving Target Indicator
NATO	North Atlantic Treaty Organisation
NBC	Nuclear Biological and Chemical
NCTR	Non Co-operative Target Recognition
Nd	Neodymium
NIS	NATO Information System
NLOS	Non Line Of Sight
NLW	Non Lethal Weapons
NQR	Nuclear Quadruple Resonance
NRT	Near Real Time
OA	Operational Analysis
OOTW	Operations Other Than War
OPO	Optical Parametric Oscillators
OPSEC	Operational Security
OPSS	Optically Activated Semiconductor Switches
ORBATS	Order of Battle
OTC	Officer in Tactical Command
OTM	On the Move
PCR	Polymerase Chain Reaction
PfP	Partnership for Peace
PHEMT	High Electron Mobility Transistors
PLD	Programmable Logic Devices
PLL	Phase Locked Loop
PLZT	Lead-lanthanum-zirconium-titanate
PMC	Polymer Matrix Composite
PSO	Peace Support Operation
PZT	Lead-zirconium-titanate
QPM	Quasi Phase Matching
R&D	Research and Development
RADAR	Radio Detecting and Ranging
RAM	Radar Absorbent Materials
RAM-D	Reliability and Maintainability
RFDE	Radio Frequency Directed Energy
RF	Radio Frequency

RIF	Radar Information Fields
RISTA	Reconnaissance, Intelligence, Surveillance and Target Acquisition
RMA	Revolution in Military Affairs
RTB	Research and Technology Board
SADARM	Sense and Destroy Armour
SAR	Synthetic Aperture Radar
SAS	Studies, Analysis and Simulation
SATCOM	Satellite Communications
SBA	Simulation Based Acquisition
SBS	Stimulated Brillouin Scattering
SET	Single Electron Transistor
SFM	Sensor Fused Munitions
SFQ	Single Flux Quantum Logic
SHAPE	Supreme Headquarters Allied Powers Europe
Si	Silicon
SIA	Semiconductor Industry Associations
SiC	Silicon Carbide
SiGe	Silicon Germanium
SOI	Silicon-on-insulator
SPOD	Sea Port of Disembarkation
SQUID	Superconducting quantum interference device
STA	Surveillance Target Acquisition
STOW	Synthetic Theatre of War
T/R	Transmit/Receive
TGSM	Terminally Guided Sub-Munition
TRACER	British Armoured Scout Vehicle
TSG	Technical Study Group
TSW	Technology Seminar Wargame
TWT	Travelling wave Tube
UAV	Unmanned Aerial Vehicle
UGV	Unmanned Ground Vehicle
UMA	Unmanned Aircraft
UN	United Nations
UV	Ultra Violet
UWB	Ultra Wide Band
VHR	Very High Risk
VLR	Very Low Risk
VLSI	Very Large Scale Integration
WAN	Wide Area Network
WEU	Western European Union
WHA	Tungsten heavy alloys
WMD	Weapons of Mass Destruction
WST	Wafer Scale Technology
YAG	Yttrium Aluminium Garnet
ZnSe	Zinc Selenium

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MEMS (Microelectromechanical Systems)
Energetic materials
Situational awareness
Trends
War games
Weapon systems

14. Abstract

This is the final report of the Long-Term Scientific Study on Land Forces in the Year 2020. This study identified the types of land forces and their capabilities and characteristics that will be required on the NATO battlefield in the year 2020 for warfighting and other military operations. This information provides SHAPE, and subsequently the major NATO Commanders, with a basis for long-term requirements and defence planning guidance.

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